Resource Adequacy and Markets

ESIG
March 24, 2020

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Resource Adequacy Responsibility in Markets

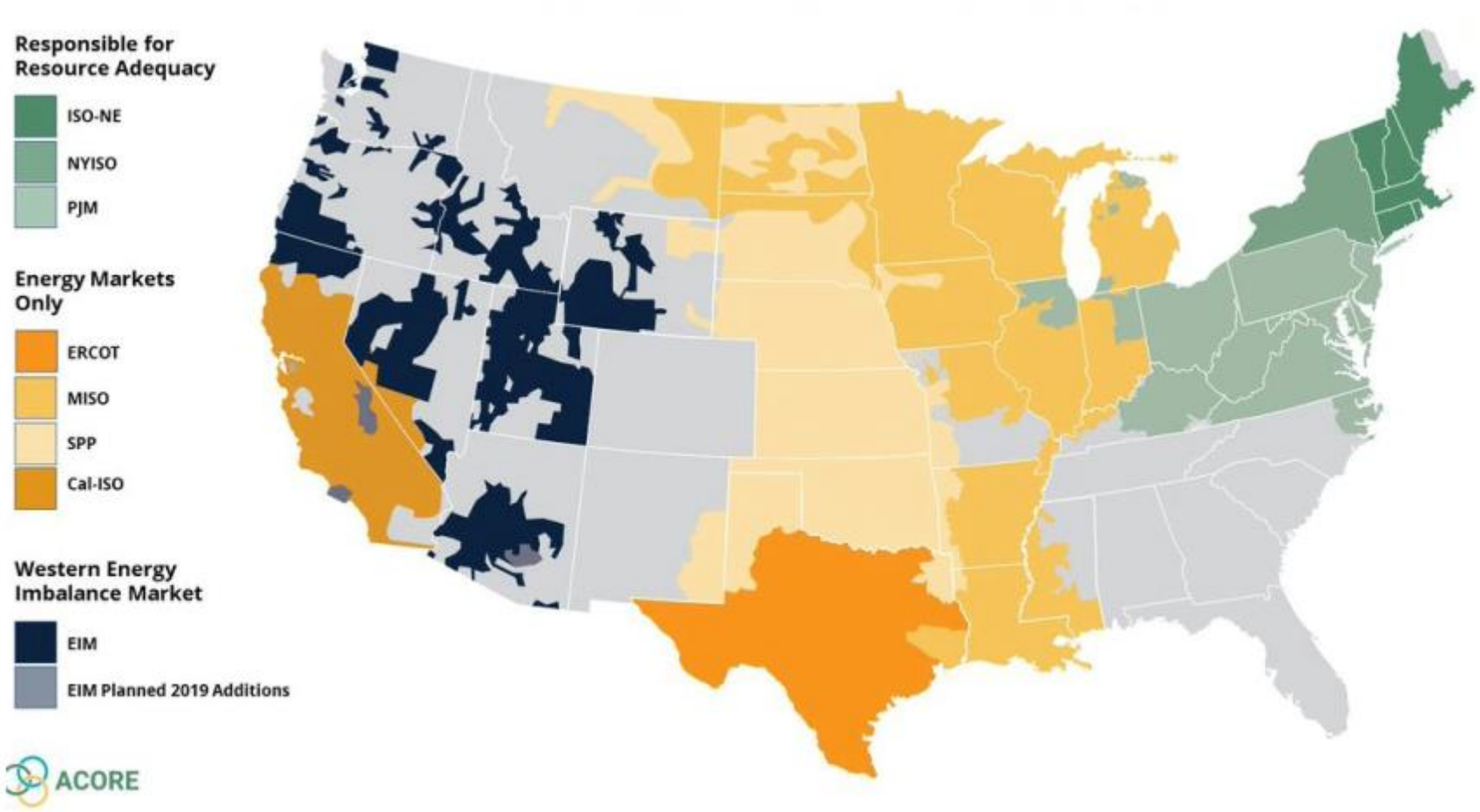
Alternative Approaches

1) State-regulated, with RTO monitoring and coordination
   - CAISO, SPP, MISO

2) RTO obligation on load-serving entities to participate in auction with auction and administrative demand curve
   - PJM, NYISO, ISO-NE

3) De-centralized through bilateral contracts and penalty of paying scarcity based real-time prices when system is short
   - ERCOT, Australia, New Zealand

Regional Market Types



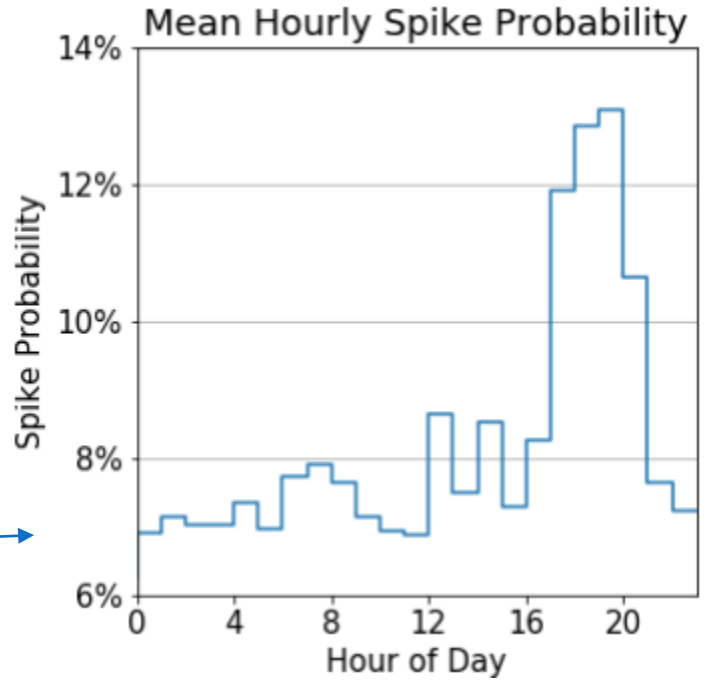
De-Centralized Market Structure

- Environmental regulators internalize externalities
- RTO/ISO balances power system and administers short term spot markets
  - Procures energy and reliability services based on engineering definitions
  - Also plans transmission infrastructure for reliability and efficiency given future resource mix, recovers cost in regional tariff
- Retail suppliers competitively procure power (hedge) with contracts to serve load
- State PUCs oversee hedging for some or all customers
  - ensure retail suppliers are credit-worthy buyers of wholesale power, have ability and incentive to procure power to serve load
- Utilities build, own, and operate monopoly T&D (not G) with regulated rates
- Independent Power Producers build and own generation to sell electricity products to retail suppliers/wholesale buyers
- Financial participants provide risk management products

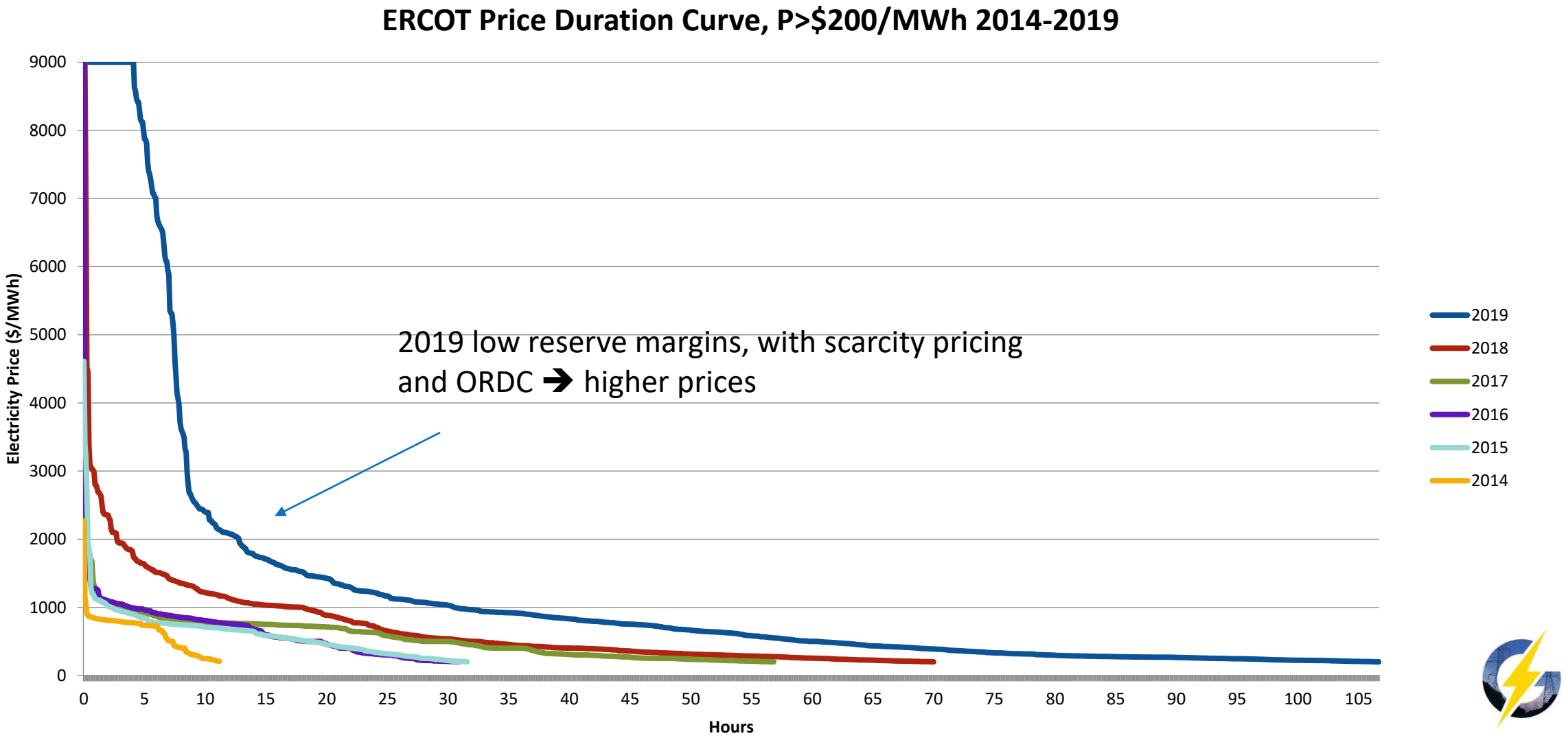
De-Centralized Market Design

- **Spot market with bilateral contracts**
  - Expect most payments and revenue in long term PPAs, priced at average cost of competitive new unit
  - Spot market for residuals and re-balancing
- **Energy at each time and location**
  - Hourly locational marginal pricing (LMP)
- **Reliability Services--technology-neutral**
  - Operating reserves, exact needs vary by region
  - Reactive support—non-market compensation
- **Scarcity pricing**
  - prevents free-riding, encourages contracting, attracts flexible resources
  - Most load hedged, and doesn't pay spot price.
- **No mitigation of state environmental policies (broad MOPR)**

Ascend Analytics CA model:



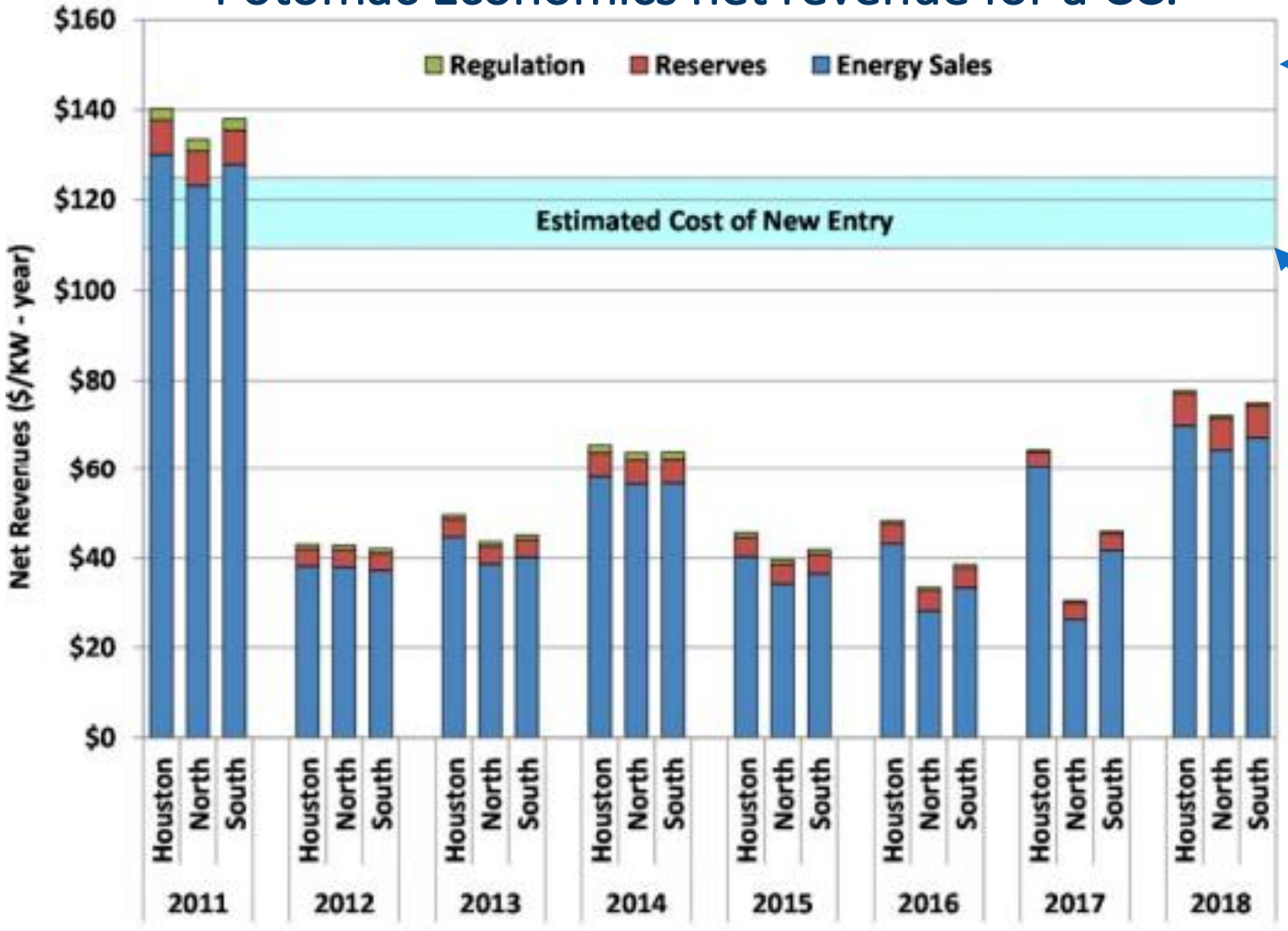
Is the De-Centralized Market Structure Working?



ERCOT Net Revenue

When reserves are low, net revenue should exceed Cost of New Entry

Potomac Economics net revenue for a CC:

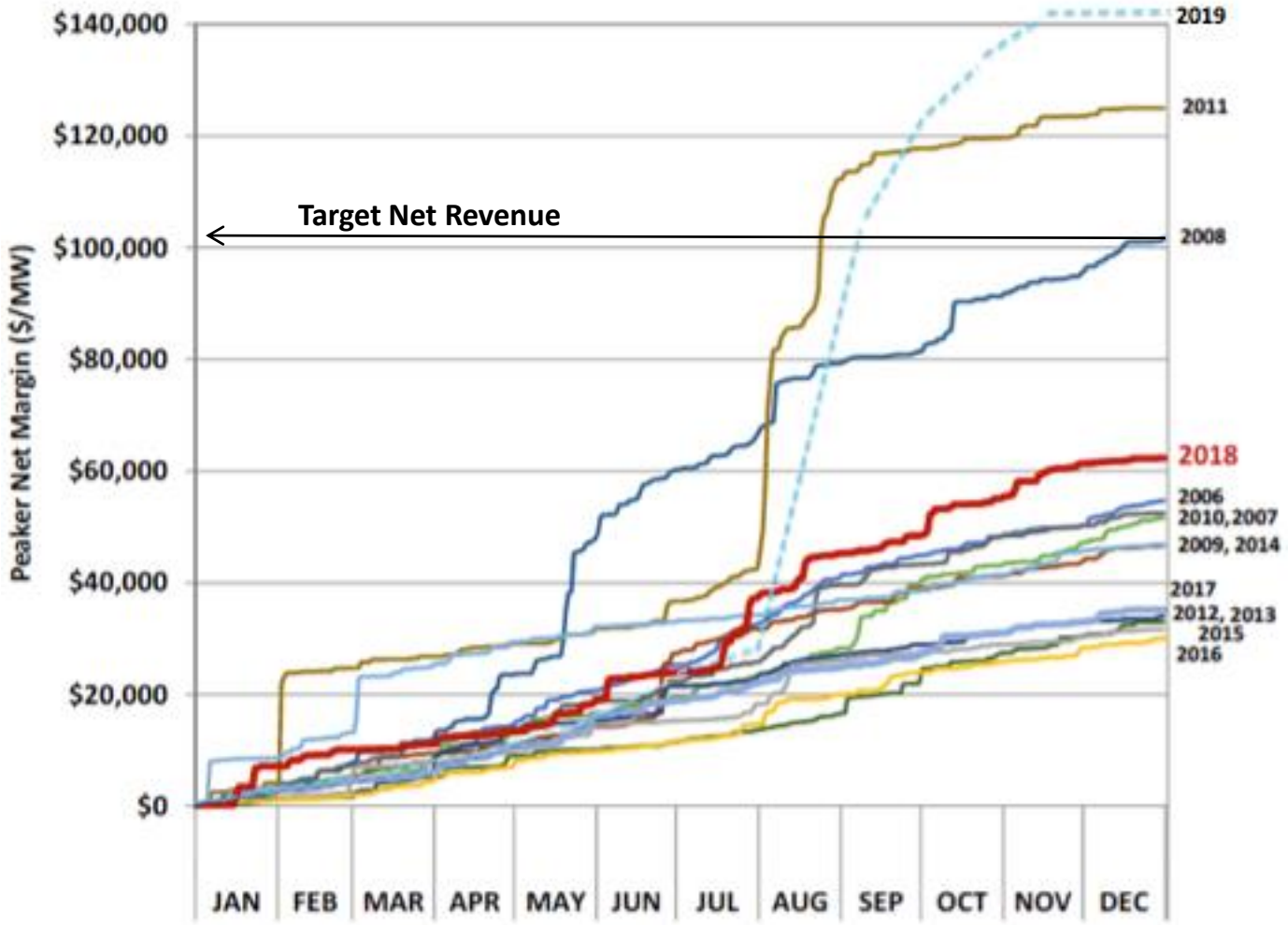


2019 peaker net rev. $146/kw-yr

Peaker CONE of $105/kw-yr

Source: Grid Strategies estimates

ERCOT Net Revenue Targets Exceeded in 2019



Renewable Energy Financing and De-Centralized Markets

- **Renewable energy characteristics affecting investment:**
  - Capital-intensive
  - Zero production cost, so energy prices can be low after capital is committed and units are operating

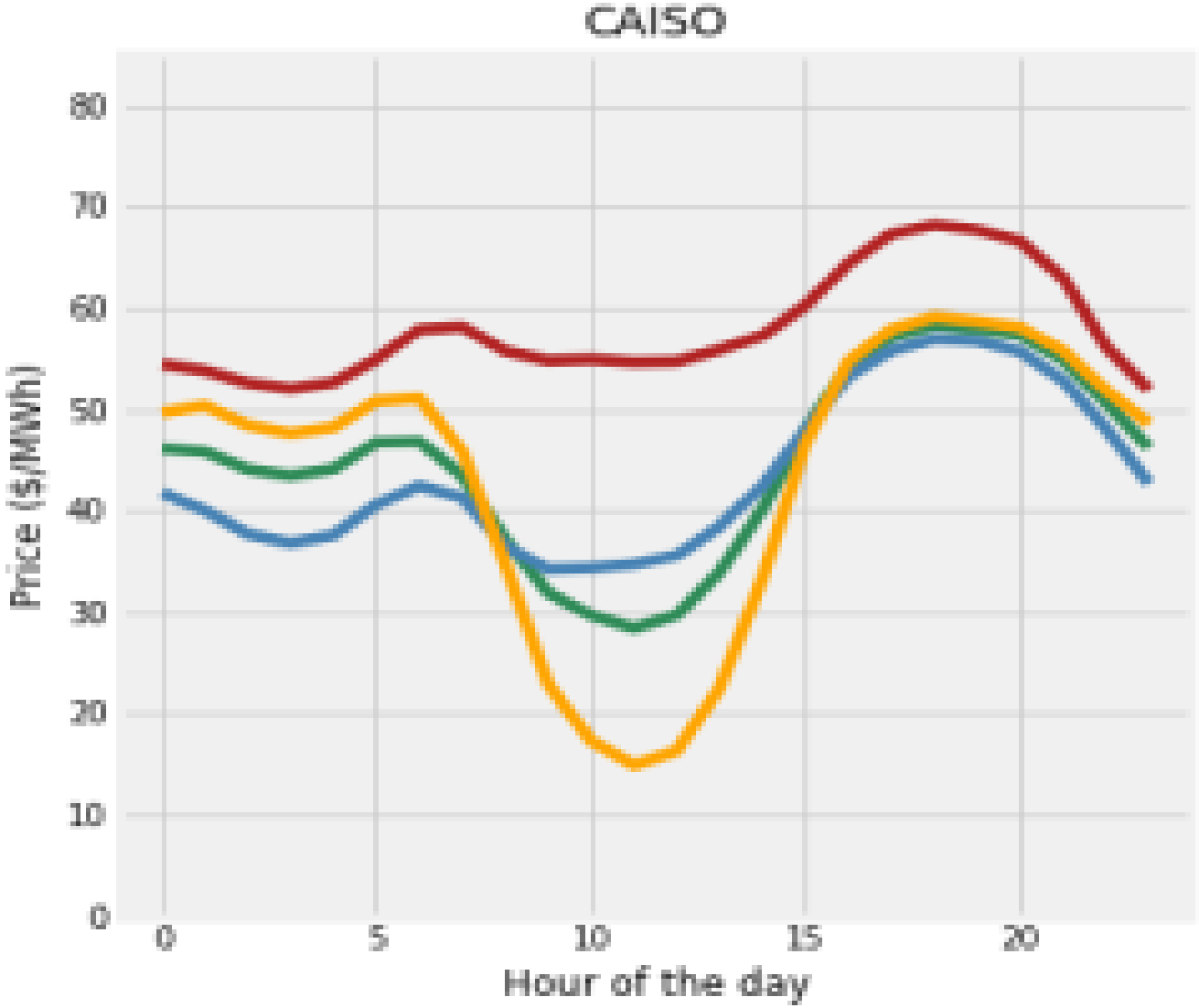
⇒Addressed through pre-arranged long-term contracts

- Provide revenue certainty to lenders
- Provide price certainty to consumers
- Can be physical or financial, many varieties

Renewable Energy Project Financing
Pre-arranged contracts hedge against low power prices

Energy prices fall at 40% renewable penetration

- 2016 portfolio
- Balanced: 20% wind, 20% solar
- High wind: 30% wind, 10% solar
- High solar: 30% solar, 10% wind



Source: LBNL

Market Prospects in ERCOT

- “We think prospects remain altogether quite constructive through the medium term with the continued rally in power boding particularly well for '20 ERCOT curves. We stress the further 0.25 std-dev improvement in ORDC parameters should drive yet higher probabilities of achieving ORDC pricing next year as well as suggesting prospects for yet another meaningful outcome on pricing (the percent of hours with ORDC & total value delivered from ORDC curves through the summer despite comparable weather earlier in the summer speaks to the benefits YoY of pricing uplift). We maintain Buy on [redacted] and perceive clear positive trends”

-Julien Dumoulin-Smith, BAML 9/29/19

Typical Generator Finance in ERCOT

- NRG signed 1.3 GW of solar PPAs in 2019 with an average term of 10 years to serve their retail load.
- "The Project entered into a hedge arrangement for the output of the project simultaneously with financial close, providing certainty of revenue for the majority of the Project's output for a 12 year period from the commencement of commercial operations ("COD"), with settlement at the [redacted] trading hub. The Project also entered into a basis hedge for a period of 3 years post-COD, mitigating exposure to transmission congestion risk through to the completion of approved transmission upgrades in [year redacted]." -Actual investor prospectus for a wind farm in Texas

Consumer Perspective on ERCOT Revenue Sources

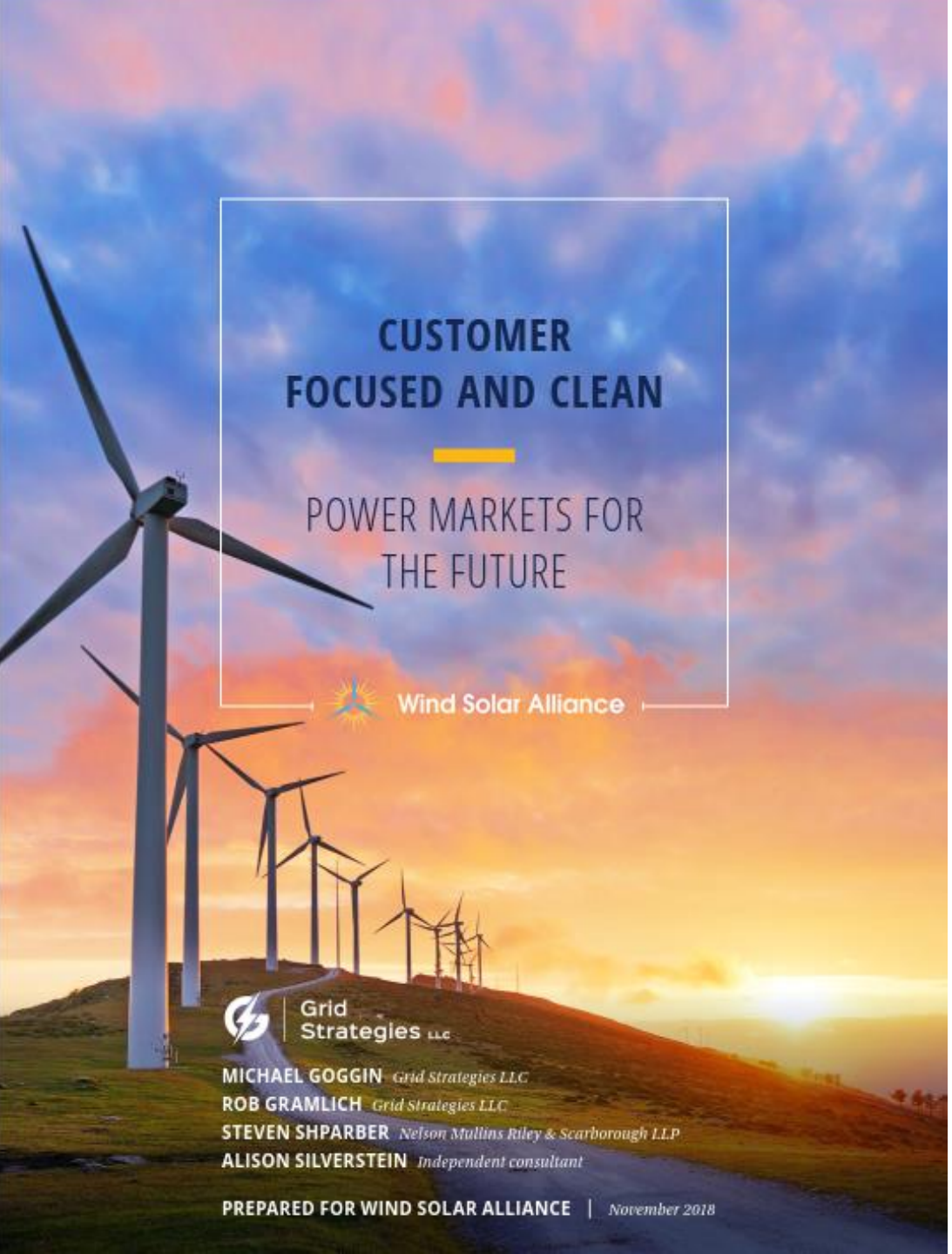
"Bilateral hedging activity and premium forward pricing provides a considerable revenue stream for generators beyond realized real-time pricing and the Operating Reserve Demand Curve (ORDC). This is an efficient market solution for entities wanting to avoid price risk… futures markets capture the risk that things may not go according to plan and very high prices may materialize. The market is exceptionally good at rationalizing these types of risks and pricing them appropriately, as the reaction to lower planning reserve margins demonstrates."

Texas Industrial Energy Consumers (TIEC)
http://interchange.puc.texas.gov/Documents/48551_25_993729.PDF p. 4.

“Issues” with central ISO/RTO capacity markets

- Subjective debates about capacity credit
- Shortages not happening at peak
- Product not well-defined in terms of value or obligations
- Attracting only one kind of new source, and more than needed
- Recent vehicle to interfere with state policy and serve as a barrier to renewable energy entry
- Dulls price signals

“Our questions should shift from ‘how many MWs do we need?’ to ‘what resources do we need to provide the full set of required system services under a wide range of possible futures?” Frew (2018)



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WHOLESALE ELECTRICITY MARKET DESIGN FOR RAPID DECARBONIZATION: A DECENTRALIZED MARKETS APPROACH

BY ROB GRAMLICH[1] AND MICHAEL HOGAN[2] ● JUNE 2019

"What wholesale market design would provide the best framework for integrating reliably and at least cost the new, clean resources that will be needed to de-carbonize the power system?"

This common question includes what model best provides clean sources with fair access, what model best drives timely retirement of the fossil

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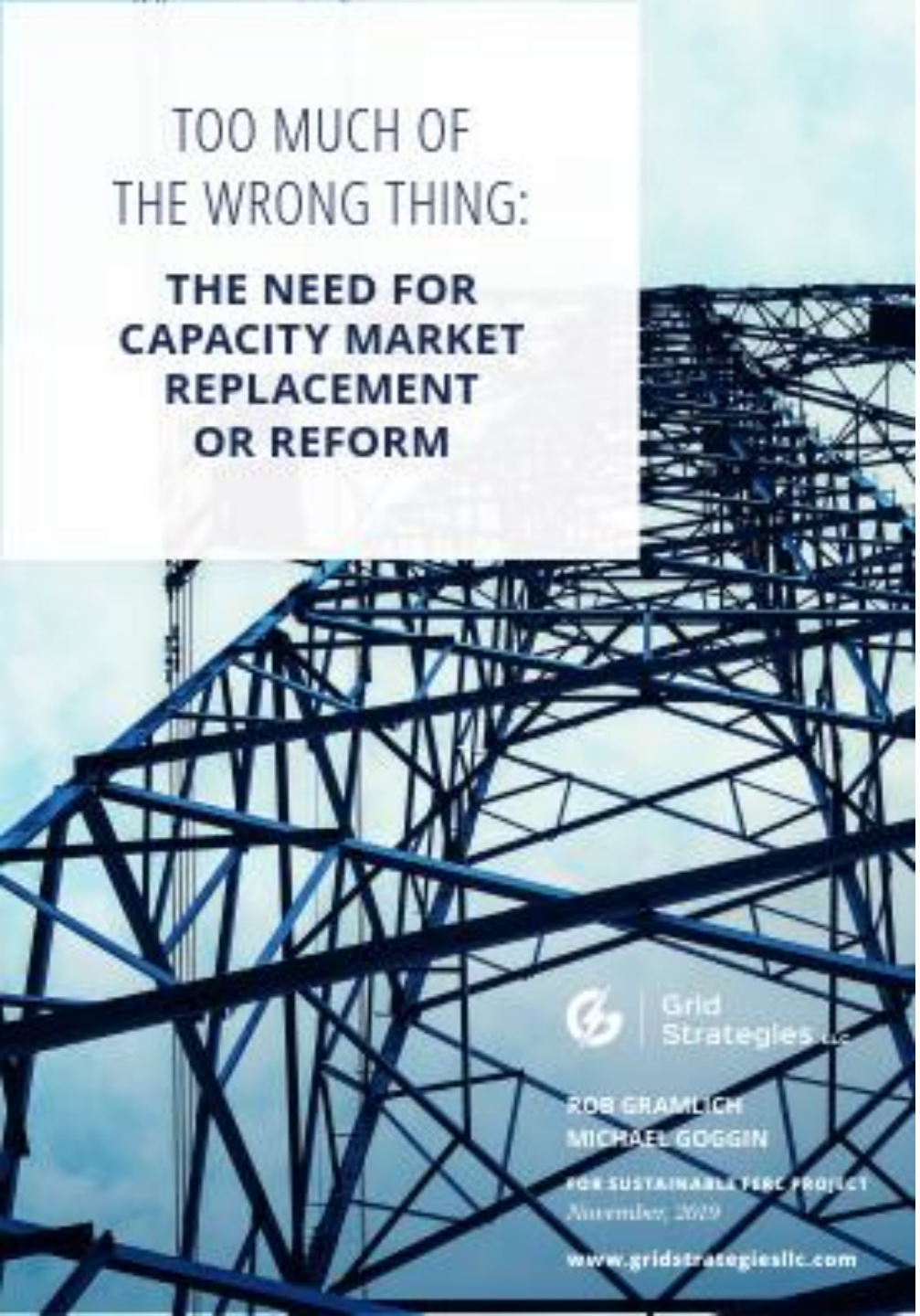

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